

Listing of Claims

1. (Currently Amended) A pressure transducer for measuring pressure in a pipeline, the transducer comprising:

a sensing tube allowing flow therethrough, wherein the sensing tube has a substantially uniform cross-section for maintaining substantially unobstructed continuous flow through the pipeline and the sensing tube, when coupled to the pipeline, and wherein at least a portion of the sensing tube which mechanically deforms by local bulging in response to a pressure on one side thereof;

at least one means for measuring deformation ~~strain gage~~ on the sensing tube for measuring deformation of the at least a portion of the sensing tube; and

a housing at least partially surrounding the sensing tube.

2. (Original) The pressure transducer of claim 1, wherein the sensing tube has a perimeter, and the at least a portion of the sensing tube extends fully around the perimeter.

3. (Withdrawn) The pressure transducer of claim 1, wherein the tube has a perimeter, and the at least a portion of the sensing tube does not extend fully around the perimeter.

4. (Original) The pressure transducer of claim 1, wherein the sensing tube has a circular cross section.

5. (Original) The pressure transducer of claim 4, further comprising a pipe flange for connecting a pipe to the sensing tube, wherein an inner diameter of the pipe flange and an inner diameter of the sensing tube are substantially identical.

6. (Original) The pressure transducer of claim 5, wherein the pipe flange has threads thereupon to mate with threads on a pipe segment which has an inner diameter which is substantially identical to the inner diameter of the pipe flange.

7. (Withdrawn) The pressure transducer of claim 1, wherein the sensing tube has a rectangular cross section.

8. (Withdrawn) The pressure transducer of claim 1, wherein the sensing tube has a square cross section.

9-10. (Canceled)

11. (Previously Presented) The pressure transducer of claim 1,
wherein the at least one means for measuring deformation includes the at least one strain gage is on a second side of the at least a portion of the sensing tube;
wherein the second side and the one surface are on opposite major surfaces of the at least a portion.

12. (Previously Presented) The pressure transducer of claim 1, wherein the housing encircles the sensing tube.

13. (Withdrawn) The pressure transducer of claim 12, wherein the housing includes a cover and a pair of pipe connectors for coupling the housing-to-pipe segments.

14. (Withdrawn) The pressure transducer of claim 13, wherein the cover is cylindrical.

15. (Withdrawn) The pressure transducer of claim 13, wherein the housing further includes a cylinder between the sensing tube and the cover.

16. (Withdrawn) The pressure transducer of claim 13, wherein the cover includes one or more access doors.

17. (Withdrawn) The pressure transducer of claim 16, wherein at least one of the access doors has an electrical connector therein.

18. (Withdrawn) The pressure transducer of claim 13, wherein the cover has open ends, each of the open ends having a housing flange attached thereto.

19. (Original) The pressure transducer of claim 12, wherein the sensing tube is attached to the housing.

20. (Currently Amended) The pressure transducer of claim 19, wherein the sensing tube includes an end portion which is attached to the housing and a central portion to which the at least one means for measuring deformation ~~strain gage~~ is mounted.

21. (Original) The pressure transducer of claim 20, wherein the end portion has a thicker wall than the central portion.

22. (Original) The pressure transducer of claim 21, wherein the sensing tube further includes a curved portion linking the end portion and the central portion.

23. (Original) The pressure transducer of claim 22, wherein the curved portion has a constant radius of curvature.

24. (Withdrawn) The pressure transducer of claim 22, wherein the curved portion is tapered, having a radius of curvature which increases closer to the thinner portion.

25. (Currently Amended) The pressure transducer of claim 22, wherein at least one of the at least one means for measuring deformation ~~strain-gage~~ is located adjacent to the curved portion.

26. (Withdrawn) The pressure transducer of claim 21, wherein the end portion includes a connecting member which is attached to the housing and a rib which is mechanically isolated from the housing.

27. (Withdrawn) The pressure transducer of claim 26, wherein the connecting member is mechanically isolated from the rib by a groove between the connecting member and the rib.

28. (Withdrawn) The pressure transducer of claim 27, wherein one end of the sensing tube is attached to the housing and another end of the sensing tube is slidably mounted in the housing.

29. (Withdrawn) The pressure transducer of claim 28, wherein the one end is welded or mechanically attached to the housing and the another end is mounted to the housing with a flexible seal therebetween.

30. (Previously Presented) The pressure transducer of claim 21, wherein the sensing tube includes a second end portion, the end portions having different outside diameters.

31. (Currently Amended) The pressure transducer of claim 100, 4, wherein the at least one strain gage transducer includes at least two strain gages, one of the at least two gages used for measuring axial strain and another of the at least two gages used for measuring circumferential strain.

32. (Currently Amended) The pressure transducer of claim 100, 4, wherein the at least one strain gage transducer includes at least four strain gages, at least two of the gages used for measuring axial strain and another at least two of the gages used for measuring circumferential strain.

33. (Original) The pressure transducer of claim 32, wherein the at least two of the gages used for measuring axial strain and the another at least two of the gages used for measuring circumferential strain are connected together in a Wheatstone bridge.

34. (Original) The pressure transducer of claim 1, wherein the sensing tube is made of metal.

35. (Original) The pressure transducer of claim 1, wherein the at least a portion of the sensing tube includes a thinner portion which amplifies the changes in shape.

36. (Currently Amended) A pressure transducer for measuring pressure in a pipeline, the transducer comprising:

a sensing tube allowing flow therethrough, wherein the sensing tube has a substantially uniform cross-section for maintaining substantially unobstructed continuous flow through the pipeline and the sensing tube, when coupled to the pipeline, and wherein at least a portion of the sensing tube ~~which~~ changes shape by local bulging in response to a pressure on one side thereof;

a sensor for measuring the changes in shape of the at least a portion of the sensing tube; and

a housing at least partially surrounding the sensing tube.

37. (Original) The pressure transducer of claim 36, wherein the sensor includes a means for measuring the changes in shape of the at least a portion of the sensing tube

38. (Original) The pressure transducer of claim 36, wherein the sensor includes at least one strain gage mounted on the sensing tube for measuring deformation of the at least a portion of the sensing tube.

39. (Withdrawn) The pressure transducer of claim 36, wherein the sensor includes at least one piezoelectric device for measuring deformation of the at least a portion of the sensing tube.

40. (Withdrawn) The pressure transducer of claim 36, wherein the sensor includes a light source and a light detector for measuring deflection of the at least a portion of the sensing tube.

41. (Withdrawn) The pressure transducer of claim 36, wherein the sensor includes a capacitance probe for measuring deflection of the at least a portion of the sensing tube.

42. (Withdrawn) The pressure transducer of claim 36, wherein the sensor includes a continuum wave source and a continuum wave detector for measuring deflection of the at least a portion of the sensing tube.

43. (Original) The pressure transducer of claim 36, wherein the sensing tube is made of a generally rigid material.

44. (Original) The pressure transducer of claim 43, wherein the generally rigid material is a metal.

45. (Previously Presented) The pressure transducer of claim 36, wherein the housing surrounds the sensing tube and the sensor.

46. (Canceled)

47. (Currently Amended) A method of measuring fluid pressure in a pipeline, comprising:

at least partially enclosing in a housing a sensing tube which includes a flow passage therethrough;

installing the sensing tube in line with the pipeline, such that substantially unobstructed flow is provided from the pipeline, through the flow passage of the sensing tube, and back into the pipeline; and

measuring strain in the sensing tube due to local bulging of the sensing tube caused by fluid pressure in flowing through the flow passage, as a representation of the fluid pressure.

48. (Previously Presented) The method of claim 47, wherein the measuring strain includes measuring strain with one or more strain gages placed on an outer surface of the sensing tube.

49. (Original) The method of claim 47, further comprising placing the strain gages in a bridge configuration to increase an output signal.

50. (Previously Presented) The method of claim 47, wherein the sensing tube and the strain gages are fully enclosed in a housing.

51. (Withdrawn) The method of claim 50, further comprising structurally isolating at least a portion of the sensing tube from the housing.

52. (Original) The method of claim 50, further comprising placing the strain gages on portions of the sensing tube which have a maximum strain response.

53. (Original) The method of claim 47, wherein the measuring strain includes measuring both axial and circumferential strains.

54-73. (Canceled)

74. (Previously Presented) A pressure transducer for measuring pressure in a pipeline, the transducer comprising:

a sensing tube allowing flow therethrough, wherein the sensing tube has a substantially uniform cross-section for maintaining substantially unobstructed continuous flow through the pipeline and the sensing tube, when coupled to the pipeline, and wherein at least a portion of the sensing tube ~~which~~ mechanically deforms by local bulging in response to a pressure on one side thereof; and

at least four strain gages on the sensing tube for measuring deformation of the at least a portion of the sensing tube; and

wherein at least two of the strain gages are configured for measuring axial strain and another at least two of the gages are configured for measuring circumferential strain; and

wherein the at least two of the gages used for measuring axial strain and the another at least two of the gages used for measuring circumferential strain are connected together in a Wheatstone bridge.

75. (Previously Presented) The pressure transducer of claim 74, further comprising a housing at least partially surrounding the sensing tube.

76. (Previously Presented) The pressure transducer of claim 75, wherein the housing encircles the sensing tube.

77. (Previously Presented) The pressure transducer of claim 76, wherein the sensing tube is attached to the housing.

78. (Currently Amended) The pressure transducer of claim 77, wherein the sensing tube includes an end portion which is attached to the housing and a central portion to which the at least four ~~one~~ strain gages ~~are gage~~ is mounted.

79. (Previously Presented) The pressure transducer of claim 78, wherein the end portion has a thicker wall than the central portion.

80. (Previously Presented) The pressure transducer of claim 79, wherein the sensing tube further includes a curved portion linking the end portion and the central portion.

81. (Previously Presented) The pressure transducer of claim 80, wherein the curved portion has a constant radius of curvature.

82. (Currently Amended) The pressure transducer of claim 80, wherein at least one of the at least four ~~one~~ strain gages ~~gage~~ is located adjacent to the curved portion.

83-96. (Canceled)

97. (Currently Amended) The pressure transducer of claim 22, wherein the at least one means for measuring deformation ~~strain-gage~~ includes:
first strain gages for measuring axial strains; and
second strain gages for measuring circumferential strains; and
wherein the first strain gages are located adjacent to the curved portion of the sensing tube.

98. (Previously Presented) The pressure transducer of claim 97, wherein the second strain gages are located on the sensing tube closer than the first strain gages to a middle of the sensing tube.

99. (Previously Presented) The pressure transducer of claim 97, wherein the first strain gages and the second strain gages are coupled together in a Wheatstone bridge.

100. (New) The pressure transducer of claim 1, wherein the at least one means for measuring deformation includes at least one strain gage.

101. (New) The pressure transducer of claim 1, wherein the sensing tube is mechanically constrained at opposite axial ends of the sensing tube.

102. (New) The pressure transducer of claim 101, wherein the sensing tube is mechanically constrained by respective pipe couplings at the opposite axial ends.

103. (New) The pressure transducer of claim 36, wherein the sensing tube is mechanically constrained at opposite axial ends of the sensing tube.

104. (New) The pressure transducer of claim 103, wherein the sensing tube is mechanically constrained by respective pipe couplings at the opposite axial ends.

105. (New) A pressure transducer for measuring pressure in a pipeline, the pressure transducer comprising:

- a sensing tube configured to be placed in line with the pipeline to allow flow from the pipeline therethrough, wherein at least a portion of the sensing tube mechanically deforms by bulging in response to a pressure on one side thereof;

- a sensor on the sensing tube for measuring deformation of the at least a portion of the sensing tube; and

- a housing at least partially surrounding the sensing tube;

- wherein the sensing tube is mechanically constrained at opposite axial ends of the sensing tube.

106. (New) The pressure transducer of claim 105, wherein the sensing tube is mechanically constrained by respective pipe couplings at the opposite axial ends.

107. (New) The pressure transducer of claim 106, wherein the pipe couplings are configured to couple the transducer to a pair of pipe segments of the pipeline, thereby defining a flow passage from one of the pipe segments, through the sensing tube, and into the other of the pipe segments.

108. (New) The pressure transducer of claim 107, wherein a substantially identical cross section throughout the flow passage is maintained throughout the flow passage and the pipe segments.

109. (New) The pressure transducer of claim 105, wherein the sensor includes at least one strain gage on the at least a portion of the sensing tube.